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ABSTRACT

Intended to assist developing countries in the essential task of preserving historical records and, therefore, deliberately oriented towards economy and a low level of technology, this study provides an outline of currently accepted standards that archivists in developing countries, especially those in tropical areas, can apply to their own situations. Following a description of the physical aspects of records and a summary of the main dangers that threaten them, guidelines are provided for the design of archive buildings; protection against specific hazards, including unsuitable levels of humidity, air pollution, light, theft, physical damage, fire, insects, mold, and animal pests; shelving and packing; exhibitions; and preserving non-traditional records, such as films and computer tapes. In addition, 13 specific recommendations are provided for the protection of records against unsuitable environmental conditions. A 70-item bibliography and a 55-item list of RAMP (Records and Archives Management Programme) publications and related documents are also included. (KM)

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STUDY ON CONTROL OF SECURITY AND STORAGE OF HOLDINGS : A RAMP STUDY WITH GUIDELINES

prepared by

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PREFACE

In order to assist in meeting the needs of Member States, particularly developing countries, in the specialized areas of archives administration and records management, the Division of the General Information Programme has developed a long-term Records and Archives Management Programme - RAMP

The basic elements of RAMP reflect and contribute to the overall themes of the General Information Programme. RAMP thus includes projects, studies and other activities intended to :

- develop standards, rules, methods and other normative tools for the processing and transfer of specialized information and the creation of compatible information systems;

- enable developing countries to set up their own data bases and to have access to those now in existence throughout the world, so as to increase the exchange and flow of information through the application of modern technologies;

- promote the development of specialized regional information networks;

- contribute to the harmonious development of compatible international information services and systems;

- set up national information systems and improve the various components of these systems;

- formulate development policies and plans in this field;

- train information specialists and users and develop the national and regional potential for education and training in the information sciences, library science and archives administration.

This study is intended to assist developing countries in the essential task of preserving historical records. Archivists in developing countries, especially in tropical areas, face severe problems. First, the climatic conditions are unsuitable : high humidity, harmful insects, bright sunlight, polluted air and severe storms all threaten the survival of documents. Second, many countries face severe shortages of money, trained personnel and training facilities, as well as finding it difficult to obtain complex machinery or spare parts. The approach of the study is deliberately oriented towards economy and a low level of technology. It provides an outline of currently accepted standards which such archivists can apply to their own situations. The study starts with a description of the physical make-up of records and the main dangers which threaten them. It provides guidelines for the design of buidings and for the protection of records against specific hazards : unsuitable levels of humidity, air pollution, light, theft, fire, insects, mould and animal pests. The problems of storing and exhibiting records and of preserving non-traditional records, such as films and computer tapes are also considered. A list of detailed recommendations and an extensive bibliography are also provided.

Comments and suggestions regarding this study are welcomed and should be addressed to the Division of the General Information Programme, UNESCO, 7 Place de Fontenoy, 75007 Paris. Other studies prepared under the RAMP programme may also be obtained at the same address.

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1. INTRODUCTION

1.1 There exists a large literature on the subject of the preservation of archival documents. This RAMP study is intended to provide archivists with an outline of current standards which they can apply to their own specific situations. It is not intended as a literature survey, but as a series of guidelines for the solution of specific problems which can be used by archivists, architects and others involved in the planning or running of archival institutions. It is, however, closely linked to recent publications and full references are given.

1.2 In particular, it is written with the problems of developing countries, especially those in tropical areas, in mind. Such archives face formidable problems; not only is their environment hostile to records, but they often face shortages of funds, trained personnel and training facilities, as well as finding it difficult to obtain complex machinery or spare parts. Consequently, the approach of the report is deliberately oriented towards economy and a low level of technology; complex machinery has not been suggested unless its use cannot be avoided and the simplest acceptable solutions have been put forward.

1.3 Records are at risk from two major types of hazard. Firstly, they may be affected by unsuitable environmental conditions : a climate which is too hot, dry, humid or polluted. Secondly, they may suffer physical damage as a result of lack of care which may result in their being exposed to fire, water, excessive light, insects and pests or to their being mishandled or stolen.

1.4 A three pronged approach is needed to the care of records. Firstly, it is important to ensure a high level of good housekeeping. The building in which they are stored should be kept clean and in good condition : rubbish should be quickly removed and storage areas kept tidy and free from dust. Any structural damage should be repaired as quickly as possible. Secondly, all records (including bound volumes) should be boxed; this is the cheapest and most effective way of providing a reasonable measure of protection against unsuitable environmental conditions, light, fire, water, insects and mishandling. Thirdly, there should be a considered, long-term plan for the preservation of the records. Information should be assembled about their current condition, the environment in which they are stored and the dangers to which they are exposed. In particular, the temperature and relative humidity levels in the repository should be measured over a long period to obtain information about the effects of seasonal climatic changes; data about the local climate and air pollution levels should be obtained from appropriate experts. The advice of specialists in fire prevention and security should be sought, while the physical

condition of the records should be examined by a skilled conservator. When all this information has been gathered, it should be possible to make a proper assessment of the situation and to draw up a long-term programme for the preservation of the records. The existence of such a programme will make it possible to allocate resources effectively and could form a basis for requests for further funding. This study, by providing detailed information about specific hazards and ways of dealing with them should help in the compilation of such a long-term programme.

1.5 Archivists who are planning new buildings should read this report in conjunction with the excellent Unesco published study, Bell, Lionel, and Faye,Bernard,La Conception des bâtiments d'archives en pays tropical,Paris,Unesco,1979 (Documentation,bibliotheques et archives : etudes et recherches).

2. THE PHYSICAL ASPECTS OF RECORDS

2.1 General considerations

Records normally consist of three parts;(1) a support base: paper, film, glass, skin, polyester tape etc.;(2) a medium in which the image or message is recorded on or in that base and (3) the image or message recorded. The medium can be ink, dye, pencil graphite, silver, metallic particles etc.. Some records such as books are composed of many materials: paper, ink, boards, adhesives, thread, and covering materials. In the case of sound recording cylinders and discs the medium simply consists of indentations in the support base; this also applies to certain video discs. In the case of vesicular films, the medium is nitrogen bubbles in a polymer.

2.2 Printed and written materials

The bases for these records are all organic substances: paper which consists largely of cellulose; animal skins and some other cellulose-based materials, notably bark and leaves. Paper is normally treated with a gelatine size to permit writing and is often coated with china-clay or other mineral pigments to facilitate colour printing. The mediums for printing and writing are normally inks which consist of a pigment in a carrier. The majority of black inks are based on carbon which is suspended in a carrier of gum arabic for writing and in linseed or mineral oil for printing. In Europe and North America iron gall ink was used for many centuries; this was made by dissolving ferrous sulphate in gallic or tannic acid and thickening the extract with gum arabic. Modern inks usually consist of synthetic dyes in an aqueous, alcoholic or oil based carrier.

2.3 Bindings

Bindings are complex structures which mainly consist of organic materials. They include boards normally made from cellulosic substances (wood or cardboard), thread, gelatine or synthetic adhesives and paper used to line the boards. Bindings are covered with a range of substances, including animal skins, coloured papers or cloths, which are normally strengthened either with starch or pyroxylin (cellulose nitrate).

2.4 Photographic records

Archives are coming to hold increasingly large numbers of photographic prints and films; for example, in 1982 the Russian Central State Archive of Cinematographic and Photographic Documents was acquiring 3,000 storage units of film and 10,000 photographic documents a year.(1)

2.4.1 Support bases

A range of materials have been used as the supports for photographs; these include paper, wood, leather, cellulose nitrate and cellulose acetate, glass, metal and polyester. Most modern colour prints and many black and white ones are made on resin-coated papers; these consist of sheets of paper which are coated on both sides with polyethylene, and they present severe problems for present day archivists.

2.4.2 Images

The images of black and white photographs are made from black metallic silver. A wide range of organic dyes and inorganic pigments have been used to produce colour prints and films. Many archivists will be familiar with diazo films, whose images consist of azo dyes. The images of photographic prints and films are normally contained in a binding medium. The most common material to be used for this purpose is gelatine; binders usually contain other agents : biocides and anti-halation undercoats; manufacturers will not normally reveal the composition of these additives. In the nineteenth century, albumen, collodion (a solution of cellulose nitrate in alcohol and ether) and starch were used as binders. Diazo films on cellulose acetate base do not have a binding medium, while those on polyester use cellulose ester.

2.5 Sound recordings

2.5.1 Cylinders and discs.

The majority of cylinders and some early discs were made from wax compounds. Shellac, made from the excretions of the lac insect was used as the basis for most discs made before the

1940s; these were normally compounds which also included fillers, such as slate-powder, limestone, pigments, lubricants and binders. In the case of certain records, notably Columbia and Edison Diamond Discs, a heavy paper central core was coated with a shellac compound. In the period between World War I and World War II, there was a growth of non-commercial recordings made by radio stations, motion picture companies and private individuals. The discs used for this work were usually made from aluminium coated with cellulose acetate or cellulose nitrate. After the Second World War, long-playing records were introduced; they were made from copolymers of vinylchloride and vinylacetate, fillers, stabilizers and other substances. In the 1950s polystyrene was used for 45-RPM discs. (2)

2.5.2. Tapes

Sound recording tapes consist of a metal oxide coating on a support medium. Some early tapes were made from paper, but cellulose acetate was widely used in the 1950s. More recently, most manufacturers have used polyester tapes.

2.6 Computer records

Computer tapes are very similar to sound recording tapes, consisting of a metal oxide coating on a polyester base. The metal oxide is held on the surface of the tape in a binder which consists of polyester urethane elastomer and various additives. Computer discs can be either hard discs which consist of thin metal sheets coated with magnetic recording material or floppy discs which are made from polyester coated with metal oxide.

2.7 Other materials

Most archival repositories possess a range of records and artifacts made from many different materials. These include seals made from waxes, resins, shellac or metal; fabrics, carved wood, paintings and drawings. Most of them would be safe if stored in accordance with the recommendations given in this report, but specialist advice should be sought if necessary.

3. SUMMARY OF THE MAIN DANGERS WHICH THREATEN RECORDS

3.1 Mishandling

The major threats to records come from human beings. Records can be damaged by mishandling,carelessness, or by deliberate criminal activities, including theft and vandalism.

3.2 Fire

Most records will burn or become distorted if exposed to fire or excessive temperatures.

3.3 Water

Experience has shown that most records will not be severely damaged by a brief immersion, provided that remedial action is taken at once. The main risks posed by water are to documents written in water soluble inks which will run; to books printed on coated paper, which may adhere; and to complex structures, such as bindings, laminated recording discs and resin coated photographic papers, which may break down as a result of uneven expansion of their different constituents. Damage may also occur if the water is contaminated or if appropriate action is not taken quickly and moulds are allowed to develop.

3.4 High temperature

A high temperature has two effects on records. Firstly, it speeds up the rate of chemical activity; for every increase in temperature of 10°C, the rate of chemical activity generally doubles and thus the rate at which archival material decays also doubles. There is evidence to suggest that even smaller increases in temperature will significantly increase the rate at which paper decays. The second effect of high temperature is that the rate of biological activity also increases; the amount of damage caused by insects and moulds is much greater at higher temperatures.

3.5 Low temperature

A low temperature will assist in the preservation of all records except the plastic reels used for the storage of magnetic tape which can shrink in cold conditions.

3.6 Fluctuating temperatures

Changes in temperature will cause materials to change dimension, sometimes quite markedly; a 731m computer tape will change its length by approximately 0.305m for every 5.6°C variation in temperature. This poses a problem for complex records made from two or more substances, each of which has a different thermal coefficient of expansion. A change in temperature will cause the two materials to change dimensions, but this occurs at different rates and thus imposes stresses on the structure of the record. Repeated 'cycling' of temperature can cause permanent damage. A simple example is computer tape; the base and coating have different thermal coefficients of expansion. If subject to constant fluctuations of temperature, the tape can become distorted, developing either transverse or lateral curvature which can make it impossible to reuse.(3) Similar problems can arise with bound volumes, laminated sound recording discs, resin coated photographic papers and other complex structures.

3.7 Low relative humidity

At low relative humidities, below about 45%, there is a danger that the fibres of parchment and leather may become embrittled and more liable to crack. There is evidence that a low relative humidity retards the deterioration of paper, but it does make it more brittle. This is not harmful if the paper is not handled in this condition and the stiffening effect is completely reversible. The glues used in bookbindings will become hard and brittle in dry conditions.

3.8 High relative humidity

The main danger of high relative humidity is that it will lead to an increase in biological activity; mould will only grow above 65-70%RH, while most insect pests flourish at higher humidities. Dyes, notably the dyes in colour photographs, will fade at a faster rate at higher relative humidity.

3.9 Fluctuating relative humidity

As is the case with fluctuating temperatures, changes in relative humidity will cause materials to change dimension. This can have marked effects on complex records. Books exposed to damp conditions will have swollen and waved edges but will develop tight edges and baggy centres if they lose too much moisture. Repeated 'cycling' may lead to permanent damage. Computer tape may become badly distorted if subject to constant fluctuations.

3.10 Air pollution

A wide range of gases generated in the modern industrial environment can harm records. The most important pollutants are listed below. (4)

3.10.1 Ozone is generated by electrostatic copiers and electrostatic dust precipitators and can enter buildings from the outside where it is produced by the effect of sunlight on motor vehicle exhausts. It is a powerful oxidant, which is capable of destroying cellulose.

3.10.2 Peroxides, which can affect photographs can be emitted by newly applied paints, bleached woods, glues and varnishes.

3.10.3 Weak organic acids, notably acetic acid, can be released by wood, composite board and polyvinyl acetate adhesive. This can affect lead objects, drawings with lead point and photographic materials.

3.10.4 Formaldehyde released by certain particle boards used in buildings and by some urea formaldehyde cavity wall foam insulations can affect photographic materials.

3.10.5 Motor vehicle exhaust and the combustion of oil, coal and gas in power stations can produce two powerful pollutant gases: sulphur dioxide and nitrogen dioxide. These react with water in the air to produce sulphuric and nitric acid, which contribute to the browning and embrittling of paper.

3.10.6 Hydrogen sulphide arises from decomposition of organic materials, for example from biological slime in air-conditioning units or generated by the ageing reactions of certain materials including hair, wool, rubber and certain dyes. This gas can cause tarnishing of silver, for example in photographic images or silver point drawings and can result in red and white lead pigments becoming black due to the formation of lead sulphide.

3.10.7 Particulates: air contains many particles which can damage archives. These include soot, dust, residues of tobacco smoke and textile fibres. Their sources include diesel and petrol engines and industrial processes; while ultrafine alkaline particles have been detected in the air inside new concrete buildings. Particles can be abrasive, dirty and sometimes acidic from absorbed sulphur dioxide. They can cause damage by making records dirty or scratching them; this is a particular problem with cinefilm, microfilm and computer tape.

3.11 Pests

Severe problems can be caused by rats and mice, while insects can be particularly troublesome in tropical areas. Birds are another danger: their nests provide homes and sources of food for a number of species of insects which can also damage books; these include the drugstore beetle (stegobium paniceum) and various carpet beetles (family : dermestidae).

3.12 Light

If light falls on documents it can cause damage. The most common situation in which records are exposed to light is during an exhibition. The bindings of volumes on open shelves sometimes show signs of damage caused by light. Invisible, short wave ultra violet light is the most damaging. Primary sources of ultra violet light are sunlight and fluorescent lamps. Visible light can also be harmful and there have been examples of documents which have faded inside display cases which were filtered against ultra violet light. The main effects of light are to speed up the oxidation of paper and thus its chemical breakdown; it causes mechanical wood pulp paper to yellow or become brown and can lead certain inks and dyes to fade. It may result in the fading of certain photographs and

lead to yellowing of their gelatine emulsions. (5) The other problem posed by lighting is that sources of light generate heat; spot-lamps used in exhibitions can cause localized drying of exhibits and can accelerate thermal degradation. The choke and ballast units of fluorescent lamps can also add a great deal of heat to show cases.

4. DESIGN OF ARCHIVE BUILDINGS

4. Location of buildings (6)

The choice of a site for an archive building is often influenced by political and financial factors, as well as purely technical requirements. The following factors should be considered when a new site is being chosen.

4.1 Safety

The site should not be swampy or liable to flooding or subsidence. It should not be close to chemical factories, explosives stores, strategic targets or in areas subject to infestation by termites. The take-off and landing paths for aircraft should be avoided, while archives buildings should not be placed next to institutions or in areas which are frequently the scene of student or labour demonstrations, picketing or other forms of social or industrial unrest. Localities which are subject to hurricanes or other storms should, if possible, be avoided, as should earthquake zones. The archive should be in a separate building, located in a position which reduces the risk of fire spreading from other structures.

4.1.1 Practicality

The site should be large enough to accommodate all foreseeable extensions and should, if possible, be reasonably close to related institutions: libraries, universities, agencies which transfer records etc.

4.1.2 External Environmental conditions

Archive buildings should not be located in areas subject to high levels of air pollution - close to power stations, oil refineries, cement factories and other sources of harmful gases and particles. Urban areas which suffer from a high traffic density, and consequently high levels of pollutants, should be avoided. Locations which are subject to humid, salty or sandy winds are unsuitable. The local climatic conditions of possible sites should be studied carefully and preference should be given to ones which are on high ground, have a cool and dry climate and are protected against sun and storms. To give one example: in a hilly tropical country, an inland site on high ground might be cooler, more sheltered and better protected against storms than a

site on the coast. In the case of a small flat island country, subject to typhoons or hurricanes, the most suitable site for an archives building might be on the leeward side.

4.2 Structural requirements of the building

An archive building should provide a secure, safe and stable environment in which to store records. The need for security is described in section 5.4. below.

4.2.1 Safety of the structure

The building should be designed to provide protection against any natural disasters which might be reasonably expected. These might include earthquakes, cyclones, floods and attacks by termites. It should be resistant to strong winds and storms. Protection against fire is described in section 5.6.6 below.

4.2.2 Environmental conditions provided by the building

An archive building should have a high degree of thermal inertia so that the interior temperature and relative humidity remain reasonably stable and unaffected by fluctuations in the exterior conditions. (7) There are two reasons for this. Firstly, it will help to minimize expenditure on heating and cooling; the energy costs of a building increase by approximately 2% for every 2° Celsius by which it has to be cooled. Moreover, a well insulated building will require simpler, cheaper environmental control equipment than one with low thermal inertia. Secondly, this approach will provide some protection when, as inevitably happens, the heating or cooling system fails.

4.2.2.1 Building and design techniques

Some protection against fluctuations in temperature can be gained by careful positioning of the structure to take advantage of any natural shade or protection against wind. In the northern hemisphere, arranging the building so that it has a small wall area on its southern face will help reduce cooling costs, while a small area of wall to the north will help cut heat loss. The surface area should be kept as low as possible to minimize heat gain or loss; this precludes the use of tower blocks which have a relatively high surface area in comparison with their volume. The structure should be well insulated with thick walls, a double roof and small, double glazed windows, possibly fitted with mechanically operated thermal shutters.(8) Local architectural traditions should be considered when planning a new archive building, as many early buildings are very successful at providing stable climatic conditions. These include structures with thick stone or masonry walls in northern Europe. Passive cooling has long been a feature of Iranian architecture: buildings were clustered together to reduce total

surface area; walls were thick and there were few doors and windows while curved roofs provided insulation and encouraged the circulation of air. (9) In tropical countries, shutters, balconies and overhangs are used both to provide ventilation and to exclude the sun.

4.2.2.2 Prevention of dampness

Every effort should be made to prevent moisture from entering the building through basements, floors, walls and drains. Basements and walls below soil level should be waterproofed on the exterior to prevent water from seeping through the walls and into the interior. Earthen floors in basements should be sealed with concrete or covered with polyethylene film to reduce the amount of moisture which is volatilized into the interior air. Open trenches and drains in work rooms and basements should be covered to prevent evaporation of water into the interior. (10).

5. PROTECTION AGAINST SPECIFIC HAZARDS

5.1 Maintenance of a safe and stable climate

5.1.1 Suitable levels of relative humidity

The control of relative humidity and, to a lesser extent, temperature, is a vital element in ensuring the survival of records. The minimum level for relative humidity (RH) is determined by the risk of cracking of fibres and embrittlement. This becomes a danger for parchment and leather bindings at 40-45%; paper is also more liable to break if it is handled at these levels. The upper limit is the level at which mould will grow; this is between 65 and 70%. So the safe range is above 40-45% and below 65%.(11) The actual limits for individual countries will fall within this range but will be influenced by local climatic conditions. In the tropics an RH of 65% should be aimed for; any attempt to achieve drier conditions would lead to excessive expenditure on air conditioning. In Europe, a range of 50-55% should be easily achievable. Published figures for RH used by archives in different climatic zones tend to reflect this need to maintain a reasonable equilibrium with local conditions. Thus, in Malaysia and Singapore, which have a humid climate, a range of 50-65% is reported. (12) The USA has a totally different climate: the winters tend to be dry and the indoor RH is even lower because of the effect of heating. As a result North American archivists find a range of 47% +/-2% acceptable. (13) In Britain conditions of 55-65% are recommended; this is partly a reflection of local climatic conditions and partly because British archives hold a high proportion of parchment which survives better in more humid conditions. The only areas in the world in which it does not appear possible to maintain RH within the range 45-65% are Canada, the northern USA and north-eastern Europe. Here the

winters are so severe that considerable heating is required and it may not always be possible to raise the indoor RH above 45% without damaging the structure of the building. The problem is that moisture added to the air would tend to move into the walls where it would freeze and cause cracking. (14) In such climates, the safest option appears to be to allow the climate within the building to change slowly through the seasons, using environmental control equipment to prevent rapid fluctuations and to ensure that RH does not fall below 35% or rise above 65%. (15) Controlling the environment within buildings is expensive and difficult and becomes even more expensive and difficult if very precise conditions are required. The main requirement is to achieve a reasonably stable RH within the safe range. The degree to which it is possible to maintain a perfectly stable RH throughout the whole year will depend on the nature of the building and the level of funding available. Although rapid fluctuations in RH can be harmful, a slow seasonal change is probably acceptable.

5.1.2 Suitable temperature levels

The control of temperature is important partly because of the influence it has on RH (RH falls proportionally as temperature rises) and partly because as temperature rises, the rate of biological and chemical activity increases and consequently so does the rate at which records decay. The range of temperatures chosen must be related to local climatic conditions because cooling and dehumidification consume a great deal of energy. A range of 15-22°C is thought suitable. (16) Archives in tropical countries will find it much more practical and cheaper to maintain a temperature at the higher end of this range.

5.1.3 Regional problems

Thomson has produced a simple model of indoor climates for museums. He has divided the world into two climatic zones: humid and arid. The humid zone includes most of south east Asia, as well as parts of Africa and the Gulf States. In these areas outdoor relative humidity remains above 65% for the whole year and consequently, dehumidification is required. The arid zone includes naturally dry areas and regions where heating is required in winter which produces very low indoor relative humidity. Humidification is required in this zone.

Although it is very much an oversimplification, Thomson's model is generally valid; most countries have either a problem with excessive humidity or are too dry. There are, unfortunately, some exceptions. In London, the major problem is excessive dryness in winter, although there may be occasional problems with dampness in August and September when outdoor relative humidity in the mornings averages 76-80%. In Ilfracombe in the more humid south west of England, however,

outdoor relative humidity averages over 80% throughout the year and dehumidification may be required during the period April-September when buildings are not heated. In Tombouctou, Mali, the main problem is extreme dryness, but relative humidity in the early mornings in July, August and September can reach dangerously high levels. (17)

5.1.4 Control priorities

Environmental control is expensive in terms of capital costs and energy consumption. It is consequently very important to have clear priorities and adequate information when specifying the equipment to be installed. The main priority must be to control relative humidity and it is only possible to do this if there are full records of indoor and outdoor conditions. The second priority must be to control temperature, but in countries with cold winters, health and safety legislation may compel authorities to provide heating for the benefit of their staff.

5.1.4.1 Storage Design

The building should provide a cool, stable environment (see section 4.2 above). Records should not be stored against badly insulated exterior walls because there is a danger of a high local RH which could encourage the growth of mould. Putting records into close fitting boxes will also help create stable conditions; although the relative humidity of the air inside the box will change as the temperature changes, the volume of water which moves between the records and the air will be very small and the records will tend to regulate the amount of water in the air trapped around them.

5.1.5 Control options (18)

1. Humid countries where outdoor relative humidity exceeds 70% throughout the year (south east Asia, Pacific states, parts of Africa and Latin America etc.). The options are, in ascending order of cost:

   a. Dehumidification using portable dehumidifiers
   b. Dehumidification and cooling using single room units
   c. Fully ducted air conditioning.

2. Arid countries where outdoor relative humidity is below 40% for most of the year (desert regions, especially north Africa). The options are, in ascending order of cost:

   a. Humidification using portable humidifiers
   b. Cooling using single room units, supplemented if necessary by portable humidifiers
   c. Fully ducted air conditioning.

3. Countries requiring heating in winter and consequently having low humidity during that season (parts of Europe and North America). The options are, in order of ascending cost:

a. Humidification using portable humidifiers during the winter
b. Humidification supplemented by dehumidifiers for damp summer days
c. Local air conditioners and humidifiers
d. Ducted air system which heats and humidifies
e. Ducted air system which heats, cools and humidifies.

5.1.5.1 Humidistats

Humidistats operate like thermostats in that they switch machines on and off at pre-set levels of relative humidity. They can thus be used to control humidifiers or dehumidifiers. The calibration on these devices is rarely accurate; a humidistat set at 55% would keep the relative humidity constant, but not necessarily at 55%. They therefore need checking with a meter. They also need monitoring as they can fail, leaving humidifiers switched on and creating an atmosphere like a sauna.

5.1.5.2 Dehumidifiers

There are two types of dehumidifier: desiccant, which remove moisture by passing the air through a drying chemical and refrigerant which cool the air below its dewpoint and then reheat it. Desiccant dehumidifiers have traditionally been recommended for use in cold climates. Unfortunately, they can emit small quantities of the drying material and this can affect photographic images. Consequently, refrigerant dehumidifiers are now normally suggested for use in archives. (19)

5.1.5.3 Humidifiers

There are three main types of humidifier: atomising, which spin or squirt small droplets of water into the air; unheated evaporative, which blow the room air through a wet absorbent material, and heated evaporative, which work like electric kettles. Atomising humidifiers are the most complex to use as they have to be filled with distilled or deionised water to prevent the deposit of minerals from the water on room surfaces. When choosing a humidifier, it is important to select one which will automatically cut out when the water becomes exhausted. Humidifiers must be kept clean to prevent bacterial infections or the growth of algae. Heated evaporative models are probably the easiest to keep clean, in good order and free from bacterial or fungal infections.

5.1.5.4.1 Air conditioning: general considerations

A well designed and efficient air conditioning system is the ideal way of controlling the environment. It should be able to control temperature and relative humidity, as well as to

provide a supply of air which has been filtered against pollutants. There are a number of disadvantages of air conditioning which might make it less attractive to archivists:

1. Costs: the capital and running costs are very high; a number of archives can only afford to run their plant during working hours. This undermines the purpose of installing the equipment. (20)

2. Plant failure: problems the author has experienced include a system in Africa which was cooling the air and raising RH to dangerous levels and a system in London which was heating the air and drying it to below 40%RH. In a number of cases it has been reported that plants are very liable to break down in the early days or months of operation. (21)

3. Maintenance: this can be difficult, costly, and, in lesser developed countries, hard to arrange because of shortages of spare parts and lack of skilled labour. There is some evidence of archivists experiencing difficulties with plant maintenance engineers who do not appreciate their particular problems. (22)

4. Air flow: poorly designed systems can result in inadequate levels of air movement which can lead to high local RH. In one case mould was observed growing on records inside mobile shelving because the air flow in that area of the repository was inadequate.

5.1.5.4.2 Air conditioning: design requirements

It is essential that archivists play an active part when a new air conditioning system is being designed. They should try to seek information from the architects on the following questions:

1. What will the temperature and relative humidity be in all areas of the building in all climatic conditions experienced in the region?

2. What will the temperature and relative humidity be after 2, 12 and 24 hours of plant failure?

3. What will be the maintenance needs of the plant after 10 years and what parts will need replacing?

4. How frequently and for how long will the plant be out of action?

5. What will the running costs be? (23)

5.1.6 Air flow

Whatever system of climatic control is adopted, it is essential that the repository be provided with an adequate level of air movement to prevent the build-up of pockets of high humidity. Mobile stacks may present particular problems in humid climates; the RH within the stacks may be higher than that in the surrounding room. If this problem does arise, it may be necessary to install mobile stacks with open tops and sides, to site air conditioning vents directly over the tops of stacks or to provide fans to improve the level of ventilation. The air flow within existing buildings can be improved by the use of fans in exterior walls or roofs to pull air through the structure.

5.1.7 Measurement

It is essential that temperature and relative humidity be measured and recorded on a daily basis. The most common measuring equipment is described below.

5.1.7.1 Wet and dry bulb hygrometers

These instruments consist of two thermometers; one has a dry bulb and records the air temperature; the bulb of the other is kept wet with a wick moistened with distilled water. In the simplest type, the thermometers are swung round and round and, after a set period, the temperatures are recorded and the relative humidity calculated from a hygrometric chart or with a slide rule. Other models force the air past the thermometers with a fan operated by a battery or clockwork. These instruments are cheap, reliable and need no calibration. They do, however, require care in use, some simple maintenance (cleaning and regular replacement of wicks) and training for the operator.

5.1.7.2 Electronic humidity meters

These are becoming increasingly widely used to measure temperature and relative humidity. They are simple to operate and, provided that the maker's instructions are followed, are accurate to within +/-2%. They do need calibration and equipment to do this is normally provided. Their major disadvantage is their cost: frequently five to ten times as much as a wet and dry bulb hygrometer.

5.1.7.3 Recording thermohygrographs

These provide an accurate method of recording temperature and relative humidity over a period. They consist of a drum carrying a paper chart with scales for temperature and relative humidity. The drum is slowly turned by a clockwork mechanism.

The temperature is recorded by means of a pen connected to a bi-metallic strip. Relative humidity is recorded by a pen connected to strands of human hair which contract and expand as relative humidity falls and rises. These instruments are simple to use, but do need to be recalibrated against a wet and dry bulb hygrometer every month because there is a danger that their readings will cease to be reliable.

5.1.7.4 Dial hygrometers

These consist of a dial with a pointer which is moved by the expansion and contraction of hair or coiled paper. They can only measure relative humidity. They are very simple to use and provide an economical way of checking conditions in showcases or in storage areas. They do need regular recalibration: some cheap models are not fitted with an adjustment screw and these are not worth purchasing.

5.2 Protection against air pollution

5.2.1 Indoor sources of pollution

Some harmful pollutants can be generated by the building structure or by work practices. These include ozone, peroxides, formaldehyde, weak organic acids, hydrogen sulphide, as well as ultrafine concrete particles (see section 3.10 above).

Fortunately, the worst indoor sources of pollution: gas stoves and oil, gas and coal heaters are not usually found in archives. It is possible to eliminate most of the indoor sources of pollution early in the design stage of a new archive building and to control many of the others by good planning and sensible work practices. The use of urea formaldehyde foam for cavity wall insulation and of particle boards for shelving or as part of the internal structure should be avoided to reduce the risk of formaldehyde pollution. Concrete walls and floors should be sealed to minimize the creation of particulates. Alkyd oil based paints should be avoided, or photographic material should not be moved into freshly painted rooms for at least four weeks. The use of refrigerant dehumidifiers is to be preferred to desiccant types, while air-conditioning systems should be properly maintained to avoid a build-up of slime. Photocopiers should be housed in a separate, well-ventilated area, away from the records, and the use of electrostatic dust precipitators should be avoided. Smoking, which can add to the air various pollutants, including formaldehyde and tarry substances, should not be permitted. The problems of air pollution in show cases are described in section 7.5.

5.2.2 Cleaning

Closely associated with the need to control indoor sources of pollution is the need to ensure that the records and storage areas are regularly cleaned. Dust can cause staining and scratching and is frequently acidic from absorbed sulphur dioxide. Repositories should be provided with sufficient electric points to allow cleaning equipment to be used without inconvenience. The best system is to use vacuum cleaners with nozzles fitted with a close mesh to prevent suction of loose papers or bindings, or damage by abrasion. Cleaning agents used in a repository should not be of a kind that might cause damage.

5.2.3 Outdoor sources of pollution

The main pollutants generated outside buildings are particles, sulphur dioxide, nitrogen oxides,and ozone. The extent to which pollutants flow into buildings and affect their contents is dependent on a number of factors. These include the permeability of the building, how tightly it is constructed and how many doors and windows it has. Ventilation can also have a major impact; a positive ventilation system which draws in air from the outside will produce concentrations of pollutants approaching those outdoors. A system which recirculates indoor air will not tend to draw in so many pollutants. Local weather conditions will also affect the picture. In windy weather there will be a difference in pressure between inside and outside and air will tend to penetrate the building. Similarly, in cold weather a heated building will tend to produce a stack effect, drawing air in at the lower levels and exhausting it at the top. In hot weather people often open windows. (24)

The levels of pollutants within buildings are normally lower than those outdoors. This is partly because of the factors discussed above and partly because the major polluting gases are absorbed by the surfaces of structures. Sulphur dioxide, for example, is readily absorbed by plaster and indoor levels tend to be about half those outside. Similarly, ozone is rapidly destroyed by organic materials and some studies have failed to find significant concentrations of ozone inside archive buildings or libraries. (25)

5.2.3.1 Control methods

There are very few ways to deal with air pollution. One obvious choice is to locate or relocate outside urban areas, but this may not be politically or financially possible. The only other wholly satisfactory solution is to install full air-conditioning. The use of simple fans and filters is not satisfactory; a fully ducted system is essential so that all the room air passes through the filters.

5.2.3.2 Air conditioning

The air conditioning system should provide a slightly raised pressure inside the building to reduce infiltration. There should be two systems of filters: one to remove particles and one which is active against gases. The use of an air-conditioning system without gas filters could accelerate the rate of decay of materials if it introduced polluted air from the atmosphere or added moisture. The most suitable filters for use against gas are water spray, which is effective against sulphur dioxide and nitrogen oxides, but not ozone; and activated carbon which is effective against ozone and sulphur dioxide, but may not always remove nitrogen dioxide. (26) A much less inflammable alternative to activated carbon is active alumina impregnated with potassium permanganate

The system needs careful design to ensure that it does not introduce vapours emitted from the solvent exhaust system in the conservation department. If carbon filters are used, they should be changed regularly or they will cease to be efficient. Care must be taken with maintenance and cleaning.

5.2.3.3 Low cost options

Some archives cannot afford to install or run full air-conditioning. Others may feel that such a system is not a priority as they are located in an area of relatively low air pollution. There are a few simple steps which these institutions can take to reduce the impact of polluted air. Firstly, all material should be boxed or wrapped in acid free paper. Ideally, the boxes should be lined either with aluminium foil which provides an impermeable barrier against pollutants, or with paper impregnated with calcium carbonate which will react with acidic gases. There is good evidence from the National Gallery in London that material which is enclosed absorbs less sulphur dioxide and becomes less acidic than material exposed to the air. (27) Secondly, windows in the repository area should be sealed to reduce the direct influx of polluted air; air coming in to the record storage area from other parts of the building will have lost much of its polluting gases as they will have been absorbed on the building surfaces. Finally, the most vulnerable materials, photographs, textiles, works of art and maps, should be stored in the centre of the building above ground level where they are furthest from the sources of pollution.

5.3 Protection against light

Provided that all records are boxed, there is no real danger from light within the repository. The only materials

which are normally in danger are the bindings of volumes kept on open shelves and documents on display in showcases (see section 7.4 below).

5.3.1 Records storage area

Light should be kept off the face of shelving by ensuring that the ends or backs of stacks butt on to the windows. Blinds, curtains or louvres should be used where necessary. The number and size of windows should be restricted to minimize heat gain or loss and improve security, as well as providing better control over illumination.

5.3.2 Lighting

The principles to be observed in designing lighting in archive buildings are safety, practicality and economy. The safety of the records should be assured by using tungsten lamps which do not emit significant quantities of ultra violet light, or by fitting tubular fluorescent lamps with filters which cut off light of wavelength shorter than 400nm. Practicality means that light levels should be adequate for the tasks which are to be performed; appropriate national standards should be observed. Economy is important because of high energy costs and because lighting can add significantly to the temperature of a structure. Filtered fluorescent lamps are the most economical source of illumination for general use. Demand lighting should be provided in appropriate situations: in reading rooms and between runs of shelves.

5.4 Security (28)

The problem of providing adequate security has not been widely discussed in archival literature. Evidence from the USA indicates that there is a problem of theft from archives, but that many institutions are afraid of admitting to losses because of the risk of damaging their reputations or scaring off potential depositors (29). The dangers facing archives include:

1. Theft of preselected items from reading rooms by members of the public. Sometimes people try to introduce forged material into records.

2. Theft of records by members of staff.

3. Casual vandalism to the building which may even extend to arson.

4. Pilfering of stores and equipment by public, staff or contractors working in the building.

5. Persons breaking and entering the building either to cause damage or to steal records or equipment.

6. Politically motivated crime: in an age where terrorism is commonplace and when many archives hold records which could be regarded as political targets, this risk should not be underestimated. (30)

5.4.1 Vetting

It is important that the backgrounds of new members of staff should be carefully checked. Consideration should be given to forbidding staff to engage in manuscript collection or dealing lest the temptation proves too great. The identity of persons wishing to consult records should be checked. At the lowest level, new readers should be asked for positive proof of identity. Some institutions ask readers to produce letters of recommendation on their first visit. Although this approach can be useful, it is difficult to administer, is open to abuse (forged letters are not unknown) and is against the spirit of the age which is in favour of freer access to information.

5.4.2 Management

One official should be directly responsible to the head of the archives for all aspects of security. In large institutions, a security committee should be appointed to provide advice on this subject. There should be regular contacts with the local crime prevention authorities.

5.4.3 Staff training and motivation

Members of staff should be properly trained to be alert to potential threats and must be carefully instructed as to the correct way to respond to incidents. There should, for example, be a formal procedure for dealing with members of the public caught trying to steal records. Everyone employed in or using archives should be encouraged to have a positive attitude to security and to see it as being for their benefit, rather than as something imposed on them.

5.4.4 General procedures

Security procedures should be carefully defined and strictly enforced. The most important ones are:

1. All entrances and exits should be guarded. For fire exits, see section 5.4.11.3 below.

2. A record should be kept of persons and vehicles entering and leaving the building.

3. Visitors (including contractors and workmen) to non-public areas should be escorted at all times.

4. The building should be carefully checked at closing time to ensure that no unauthorized person or vehicle is on the premises.

5. There should be some form of night surveillance; either by means of irregular patrols by watchmen or by the use of intruder alarms.

6. Readers should not be allowed to take bags into the reading rooms. Random searches of readers' bags can have a valuable deterrent effect.

7. The building should be kept as clean and orderly as funds allow; this encourages readers to respect the institution and discourages vandalism.

8. There should be an effective system of controlling the use of keys.

5.4.5 Control of records

The strong rooms/stacks are the safest area in the building and all records should be stored there when not in use. There should be an effective method of recording the issue and return of documents so that the location of every item is always known. If resources permit, all documents should be stamped with the name of the record office; a safe, indelible ink should be used.(31) All documents should be clearly marked with their reference number.

5.4.6 Reading room design

A raised desk should be provided for a member of staff and all areas of the room should be visible from it.

5.4.7 Reading room procedures

The reading rooms should be under continuous surveillance. The issue of items to readers should be recorded and, if possible, records should be checked when they are returned. Boxes of loose papers present a particular problem. No reader should be allowed more than one at a time to prevent items being accidentally transferred from one box to another. Ideally, the contents of containers should be checked before and after issue.

5.4.8 Fragile items

Archives should have a clear procedure for dealing with fragile material. Records which are in a bad condition should not be produced to readers. If resources permit, fragile or heavily used documents should be microfilmed; electrostatic copies should be substituted for individual items. (32)

5.4.9 Valuable or attractive items

Records which are very valuable or easily saleable such as photographs or postage stamps should only be seen under the direct supervision of a member of staff.

5.4.10 Rules (33)

All archives should have a set of rules governing the conduct of readers. These should be prominently displayed and drawn to the attention of all visitors. The following is intended as a simple model for a set of rules:

1. The head of the institution may exclude any reader who ignores these rules or who behaves in a disorderly or unsuitable fashion.

2. Bags and containers brought into the building may be searched.

3. Bags and bulky objects must be deposited in the cloakrooms.

4. No food or drink or other items likely to harm documents may be taken into the reading rooms.

5. Smoking is not permitted.

6. Only pencils may be used in the reading rooms; ink, ballpoint, felt tipped and fluorescent highlighting pens may not be used for any purpose.

7. Documents must be handled with great care.

8. Documents may not be marked in any way.

9. Documents may not be folded.

10. Readers must not lean on documents or place papers or book on them while making notes.

11. Book rests should be used when consulting volumes.

12. Loose papers must not be rearranged.

The rules should also include any other relevant restrictions

such as ones on photography, the number of documents which may be produced to readers or the use of microfilms instead of original records.

5.4.11 Building design

Architectural design can help greatly to reduce the danger of crime.

5.4.11.1 Exterior of the building

The building should be an 'island' site,i.e.,one with free access round the whole perimeter, which should be clearly lighted in the hours of darkness. The grounds around the site should be fenced. There should be no trees, drainpipes or cables which would allow an intruder to climb onto the building. The structure should have a smooth shape with no recessed windows or doors, dark corners, overhangs or niches which cannot be directly observed. (34) Particular care must be taken if the building is undergoing construction or maintenance work; builders' ladders and scaffolding present particular hazards.

5.4.11.2 Windows

The windows should be small to reduce the risk from sunlight, to minimize heat gain or loss and to improve security. Those on the ground floor should have the moulding on the inside and the glazing should be protected. This can be achieved by the use of toughened glass or by fitting metal bars or grilles. Ideally these should be fitted internally, but if this is not possible, then adequate precautions should be taken to ensure that they cannot be removed. It may be necessary to extend these precautions to windows on upper floors; this will depend on their size and location. (35)

5.4.11.3 Doors

The number of exterior doors should be kept to the minimum that meets the need for an adequate provision of fire escapes. All doors should be reinforced with a steel plate, the hinges should be on the inside and the frame should resist bending. The hinges and locks should be of a suitably high quality. Fire exits should only be capable of opening from the inside and should be protected by intruder alarms. No exterior door should open directly into the record storage area. (36)

5.4.11.4 Roofs

All entrances to the roof should be secured. Skylights

and other rooflights should be protected by bars; doors should be locked. (37)

5.4.11.5 Interior

The most important security measure is to separate the record storage area from the rooms to which the public have access. This can be achieved by storing records on different floors from those used by the public or by ensuring that doors into the strong rooms do not open directly into public areas. All access points between the two zones should be controlled by staff. Controls for heating, ventilation, lighting, power etc. should be located outside the record storage area.

5.4.11.6 Shared buildings

The use of shared premises often makes it very hard to establish a security zone in which the records are stored. Such accommodation requires very careful planning which might involve the use of intruder alarms and a key system which restricts access to the secure area to members of the archive staff. (38)

5.4.12 Electronic security devices

TV cameras, alarms and sensors may be used to supplement physical security measures such as locks, barred windows and strengthened doors. The main advantage of such devices is that they are reliable and very sensitive; unlike human guards, they are not subject to fatigue or boredom. However, their main weakness is that they cannot react to an intruder: all they can do is to make sufficient noise to alarm the criminal and alert a human guard. Although such equipment can be valuable in some circumstances: to protect fire escapes, in shared buildings or at night, it should never be used as an alternative to good design and the construction of a secure building. Care should be taken to ensure that guards are available to respond to an alarm. Alarms should be connected to a central monitoring station which is continuously manned.

5.5 Protection against physical damage

There are two simple steps which can be taken to protect records against damage from handling. Firstly, all material should be securely packed (acid free containers should be used if resources permit). Secondly, all staff, including cleaners and porters, should be properly trained and motivated to handle documents correctly.

5.5.1 Protection during copying

Documents are at risk of damage when being microfilmed,

photographed or photocopied. It is important that such processes are effectively supervised and controlled.

5.5.1.1 Accommodation

Cameras and copiers should be located in a room which is not used for the storage of documents. The room should be well ventilated and have a climate which is similar to that of the repository. A separate room must be provided for processing film and photographic paper. Documents must never be taken into this area because of the hazardous chemicals which are used.

5.5.1.2 Support

Surfaces used to support documents for filming or copying should be smooth, clean, flat and large enough to support the whole surface area of the document. Records may be held in place by padded weights, straps, or light magnets, but not adhesive tape or adhesive material. Documents with seals, loose or flaking material, or crayon or charcoal writing should never be placed under photographic glass. Care should be taken to avoid straining or scratching bound volumes.

5.5.1.3 Electrostatic copiers

These present serious hazards to documents and books. Copiers with flat platens are the safest; those that move the document automatically and those with mobile platens should not be used. Documents with loose or flaking material, or too large to be adequately supported by the top surface should not be copied on electrostatic copiers. Great care should be taken when copying bound volumes to avoid damage to the bindings.

5.6 Fire

5.6.1 Causes

The major causes of fire are electrical faults, carelessness and arson. In the period 1978-1983, there were 34 fires in libraries in the USA; of these, 3 were electrical, one spread from a caretaker's living quarters, one was caused by a contractor and the rest (82%) were the result of arson. Fires caused by contractors can be devastating; in 1879, a workman heated a frozen pipe with a naked flame and caused a fire which destroyed some major collections in the Birmingham Free Library. Arson is a major, and increasing threat; in 1966 an arsonist caused a fire which burned 70,000 books in the Jewish Theological Seminary Library in New York. Arson may also have been the cause of the fire at the Military Personnel Records Centre, St Louis, Missouri in 1973, which destroyed 17 million servicemen's records. (39) In archives the worst threats come from

conservation laboratories, workshops, offices, kitchens and areas undergoing building or maintenance work.

5.6.2 Behaviour of fire

Fire generates smoke, fumes and heat and may spread via stairs, lift shafts and other openings. Flames may emanate from windows and spreading upwards may, by radiation, ignite the contents of the floor above. (40) Apart from the obvious dangers of heat and smoke, the attempts of the fire brigade to extinguish the flames can be damaging; high pressure fire hose streams and large quantities of water can harm records. Photographic materials are especially susceptible to heat and steam.

5.6.3. Work practices

It is important that all records be housed in strong boxes and that these be stored on shelves at right angles to the aisles. The fire at the Military Personnel Records Centre was spread because the ends of the boxes collapsed and records spilled onto the floor spreading and feeding the flames. (41) The records storage area should be kept clean and tidy and should only be used for the storage of archival material. Smoking should be forbidden entirely, or restricted to specific areas: offices, canteens and rest rooms. Contractors should be supervised at all times, and particular care must be taken if they are welding or stripping paint.

5.6.4 Staff training

Staff should be trained to react to fire: their first response should be to sound an alarm and then, if it is safe to do so, to attempt to extinguish the flames. Training should be provided in the use of alarms and extinguishers. There should be a comprehensive evacuation plan and regular fire-drills should be held.

5.6.5 Cooperation with fire authorities

It is important to seek the advice and cooperation of the local fire brigade.

5.6.6 Building design

The building should conform to national regulations respecting design, construction methods and fire escapes. Such regulations are usually primarily concerned with the protection of life; archive buildings demand a high level of security against both fire and damage caused by fire fighting. Advice should be sought from appropriate experts.

5.6.7 Construction

All building materials should be non-combustible; structural steelwork should be encased in concrete, masonry or other fire-resistant material. If there is a danger of fire spreading from other buildings, then metal framed windows with wired glass should be fitted. Roof voids should be broken by fire stops; linings and covering materials should be non-combustible. (42)

5.6.8 Compartmentation

All experts agree that the main way to reduce the danger of fire is compartmentation. Open, multi-tiered stacks encourage the spread of flame. Buildings should be divided into small compartments of fire-resisting construction, each of which will contain a fire and ensure the stability of the building structure. Opinion varies as to the maximum size of a compartment; a maximum floor area of 200m is sometimes suggested. In order to achieve this, walls should be capable of resisting fire for at least four hours. All openings in them should be fitted with self-closing doors or with doors or shutters which are operated by automatic devices or an alarm system. Such doors or shutters should be fire-resistant and their closure mechanisms should be regularly tested. Fire can break through openings such as stairs, liftshafts and ducts; these should be protected by walls and doors of non-combustible materials; spaces round pipes and conduits should be sealed. Air-conditioning ducts should be fitted with detectors which are capable of automatically shutting down the system and actuating dampers to prevent the flow of smoke. (43)

5.6.9 Electrical system

This should conform to national standards and be regularly inspected and tested. If resources permit, the use of flame retardant insulation and totally enclosed metal clad electrical fittings is strongly recommended. All electrical equipment used in the building should be properly maintained and inspected by qualified personnel at regular intervals.

5.6.10 Detection

Compartmentation only confines fire to a small area. It is important that this be supplemented by an automatic detection system. A wide range of detectors are available: photoelectric devices which respond to smoke, ionizing systems which sense the presence of the products of combustion and flame and heat detectors. At present, ionization devices are the preferred

choice. Any system should sound an alarm, indicate the location of the fire, close fire shutters and doors, shut down the air-conditioning system and operate dampers in the ducts and send a signal to the fire authority or a monitoring station. The most important factor, however, is the speed of response. It is essential that a guard or fire officer attend an alarm within five to ten minutes and use a hand held extinguisher to fight the fire. If response time is much longer, then a large fire may have developed. (44)

5.6.11 Extinction systems (45)

Because detectors depend on response by human beings and because this response may be delayed, the use of automatic extinction systems is suggested. None of the existing methods is ideal. The options are:

1. Carbon dioxide: this reduces the amount of oxygen below the level needed for combustion. The system requires small, totally enclosed strong rooms and the plant requires a great deal of space. The gas reduces the oxygen content of the air to below that needed to support life and carbon dioxide systems should be combined with automatic warning devices and other safety procedures.

2. Halon: this inhibits the reaction between fuel and oxygen. It too requires a sealed vault. The vapour is relatively non-toxic to humans. It is very expensive and is rarely used to protect whole buildings. Halon is the best choice to protect small, enclosed vaults used for the storage of computer tapes, audio visual materials etc.

3. Sprinklers: these are relatively cheap and may be used to protect whole buildings. Modern systems are well protected against accidental discharge and are so designed that only the heads directly over the fire will discharge water. An American Library Association survey of water damage in libraries found no evidence of accidental sprinkler discharge. 70% of all fires are extinguished with one sprinkler head. Although archivists are understandably reluctant to install sprinklers, it is probable that the damage caused by sprinklers is far less than that caused by fire hose streams. A sprinkler can immediately extinguish a fire by using a small amount of water (90-140 litres/minute), whereas at the Klein Law Library fire in Philadelphia in 1972, the firemen were pumping 50 tonnes of water per minute at the height of the blaze.

5.6.12 Hand-held extinguishers

Automatic extinction systems should be supplemented by adequate supplies of hand-held extinguishers of the high pressure water or dry powder types. Wall-mounted fire hose reels should

also be installed outside the record storage rooms. This equipment should be checked and tested regularly.

5.7 Protection against water

The major threats come from severe storms associated with badly maintained guttering or roofs, failures of internal plumbing and water used in firefighting. Water can also enter buildings as a result of blocked or over-flowing drains in basements. Storing documents in boxes will help to minimize the damage caused by flooding.

5.7.1 Maintenance

It is important that all roofs, guttering and plumbing are regularly inspected and properly maintained.

5.7.2 Structure

Basement accommodation is not recommended but, if its use cannot be avoided, adequate methods of waterproofing should be used. Sewage, water and heating pipes should, if possible, be excluded from the storage areas. Provision should be made for drainage of water that may accumulate as a result of a flood or fire-fighting. Shelves should be a minimum of 150mm above floor level to reduce the danger of water damage. The use of electronic sensors which detect the presence of water and sound alarms should be considered. (46)

5.7.3 Disaster planning

Archives should compile a disaster plan to enable the staff to cope with severe water damage. This should be in three sections:

1. Emergency actions, including information about the electricity supply, water and drainage in the building, availability of basic emergency equipment (mops, buckets, brushes, protective clothing, torches,containers, etc.) and names and telephone numbers of senior staff and emergency services.

2. Short-term arrangements for dealing with water-soaked documents, including availability of dehumidifiers, drying papers, containers and freezers.

3. Long-term plans for drying soaked material, including provision of a dry, ventilated space and appropriate equipment as well as access to freeze-drying facilities if these are available (47).

5.8 Protection against insects, mould and pests (48)

Provision of a clean, well ordered-building with suitable temperature and relative humidity will do much to prevent problems with these pests. Simple precautions such as boxing all records, forbidding eating in the repository and ensuring the rapid removal of all waste are essential. Careful inspection and, if necessary, fumigation of all newly acquired material is also important.

5.8.1 Rodents

Mice should be prevented from entering the repository by sealing the exterior; holes should be sealed with steel wool and caulking compounds. Occasional searches should be made for signs of mouse droppings. Traps should be used in any areas in which droppings are found. Poison baits should not be used; the mice will die in walls, floors and ceilings and their bodies will provide food for carpet beetles.

5.8.2 Birds

Birds should be discouraged from nesting on archive buildings by preventing their getting access to nest sites. The assistance of professional pest control firms should be sought if necessary.

5.8.3 Fungal damage

This can occur as a result of raised levels of relative humidity due either to a failure in the environmental control system or because of local problems in one part of the repository; such changes in temperature or ventilation can lead to condensation. Alternatively, infected or damp records can be introduced into the repository and subsequently develop mould. The fungi can damage records by breaking down and absorbing cellulose or protein molecules and may generate acidity, while they can also cause severe staining. (49)

5.8.3.1 Treatment

If an outbreak occurs, the first course should be to try to establish the cause and, if possible, to remedy it. Badly infected items should be removed from the storage area to await treatment.

5.8.3.2 Small outbreaks

Small infections of fungi on bindings or manuscripts can be treated by first cleaning the record and then by applying a fungicide. Those recommended are:

1. an aqueous solution of 1,1 biphenyl-2-ol (or its sodium salt) 0.5g/l solution.

2 brushing with a rag impregnated with thymol in an organic solvent 100 g/l solution.

Safety precautions should be observed: the operator should wear suitable gloves and handle the solution under a fume hood or in a fume cupboard.

5.8.3.3 Larger outbreaks

Badly infected records should be exposed to thymol vapours in a properly constructed fumigation chamber for a period of 7-10 days.

5.8.3.4 Interleaving

In some circumstances, it may be necessary to deal with outbreaks by interleaving books with papers impregnated with a volatile fungicide. Sheets of absorbent paper should be dipped in fungicides (see section 5.8.3.2) and allowed to dry. When dry, they can be placed between pages of books or files; normally, one sheet should be placed every 3mm.

5.8.4 Insects (50)

The first priority must be to prevent insects from gaining access to the repository. If cockroaches are a problem, a 2m wide gravel barrier should be installed round the building. Termites may need more elaborate precautions : the structrure may need to be enclosed by a ditch 1m wide and 1.5 m deep fitted with metal anti-termite strips. All routes through which insects could enter the building should be blocked : doors and windows should be screened; openings round windows should be filled and cracks in the structure should be repaired. Ivy,vines and other plants should be removed from the outside walls, while debris, leaves and twigs should be removed from roofs, gutters and the exterior of the building. Possible habitations for insects should be eliminated: damaged plasterwork should be repaired; voids where pipes penetrate walls or pass through floors should be treated with silica gel or a mixture of silica gel and pyrethrum; the same mixture can be used underneath cabinets and closed bookcases to prevent silverfish from attacking their contents. Regular vacuum cleaning, particularly around the perimeters of rooms will do much to eliminate insects.

5.8.4.1 Insect infestations

Infestations within the building may be dealt with by the use of insecticidal sprays which can be used around the perimeter and at the base of shelves; such sprays should not be allowed to come into contact with documents. As an alternative, sticky glueboards can be used to trap insects, while insecticide resin

strips which contain the insecticide dichlorvos (DDVP) can be used in enclosed spaces. If documents are infested, the safest course is probably to expose them to p-dichlorobenzene in a fumigation chamber. They should be fumigated for 7-10 days to kill any live insects; this procedure will not destroy eggs and it may be necessary to repeat the process after three weeks to deal with any insects which may have subsequently hatched out. It is important to observe appropriate precautions:the use of gloves, goggles and a respirator when handling this material.

5.8.4.2 Major infestations

Major infestations are difficult to deal with. In the past, some very toxic chemicals : methyl bromide, ethylene oxide and hydrogen cyanide have been used. A number of countries have imposed very strict restrictions on the use of these chemicals. Any archivist who is faced with a serious infestation should seek advice from the local department of agriculture or other appropriate experts.

5.8.5. Deep Freezing

Recently published research from the USA shows that the simplest and safest method of dealing with insects is by freezing. If infested material is sealed in a polyethylene bag and frozen to -40°C, the insects will be killed. The books can then be allowed to thaw gradually inside their containers.(51) Parker indicates that insects may be killed simply by heating; whole buildings can be disinfested by raising the interior temperature to 60-63°C for six hours; individual volumes can be treated by heating to 54°C for three hours in a humidified oven. Such an approach is not recommended for original records.

6. SHELVING AND PACKING

6.1 Shelving

The provision of shelving is very much dependent on the available financial resources. Ideally, well-built, properly painted and easily adaptable metal shelving should be installed. The following are the minimum requirements for any system of shelving:

1. The shelves and uprights should be strong enough to carry the potential load.

2. They should be made of non-combustible material: steel or fire-proofed timber.

3. They should not have features which might damage documents, including sharp angles, projections or unsuitable chemical

impregnation.

4. They should permit free circulation of air: this is particularly important with mobile shelving. Where possible, the backs, sides and tops of bays should be open. If cupboards or glass fronted bookcases have to be used, their doors should be removed and the tops drilled. It is quite common to find stagnant air and mould inside closed bookcases, especially in tropical countries.

5. The shelves should be arranged to facilitate production. Runs of shelving should not normally exceed 10m in length; the aisles between shelving should be wide enough to allow documents to be easily handled: the width should not be less than the depth of the deepest shelf plus 500mm. Gangways should be wide enough to allow the use of trolleys.

6. There should be a sufficient number of deep shelves and drawers to accommodate large documents, plans and maps.

6.2 Packing

The highest priority should be given to packing records. Placing documents in boxes provides protection against mishandling, pollution, light, fire, flood and insects, as well as providing them with a reasonably stable environment.

6.2.1 Materials

To some extent the quality of packing depends on availability of resources. Ideally,all paper-based containers should be acid-free. Adhesives used in boxes should be acid-free and stable; staples or wire stitching should be non-corrodible. Cloth used for wrapping should be acid-free and undyed; if plastic sheet is to be used, polyethylene or polyethylene terephthalate (polyester) should be specified.

6.2.2 Containers

All containers used to store documents (boxes, folders, portfolios, wrappers) should be strong enough to provide adequate support and protection and should not have any rough surfaces or protruding fastenings which might damage the records.

6.2.3 Procedure

Before documents are packed, they should be carefully examined for corrodible materials: staples, pins, paper-clips or rubber bands and these removed. Crumpled papers should be

flattened before packing.

6.2.4 Volumes

These should normally be boxed; ideally in a drop spine box, or at the very least in a container which holds the book so that it does not slip when the box is moved and places it under light pressure. (52)

6.2.5 Files and loose sheets

Loose sheets should be protected by acid-free file folders or placed in acid-free envelopes. Such material should then be boxed; the boxes should be filled to provide support for their contents. Any space within the box should be filled with padding. Normally, documents should not be folded, but a few oversized sheets in a record can be folded once. Opinions vary as to whether to place boxes on their edges or horizontally. Storing boxes on their narrower edges is very economical in the use of space, but it may impose severe strains on brittle papers. Horizontal storage is safer, but uses more space. (53)

6.2.6 Outsize documents

These include maps, plans, posters, drawings etc. Such items should be placed in acid-free file folders (up to twelve documents per folder) and stored flat in drawers or placed on repository shelving fitted with solid backs, sides and tops and a front dust cover. Very large items may be rolled round cardboard tubes covered with acid-free paper and protected by wrapping in cloth and stored flat on shelving. In some situations, the use of vertical storage systems in which documents hang from rails has proved to be satisfactory. Documents to be stored in this way should either have guards attached to one edge, or be encapsulated between sheets of polyester. Such systems are not suitable for documents which are heavily used or in archives without effective means of controlling the environment, because high humidity can build up inside them.

6.2.7 Seals

Seals, whether applied or pendant, should be protected either by padding with cottonwool encased in polyethylene or by storing in polystyrene boxes. Lead seals require protection against weak organic acid vapours which will cause corrosion and should be packed in polyethylene bags and stored in metal drawers.

7. EXHIBITIONS

7. General considerations

Exhibitions present a conflict between the need to preserve material and the desire to make it available. The major problems are maintenance of a stable environment, display of bound volumes, protection against light, protection against pollution and security. Archivists also face difficulties when lending documents for other institutions to display. (54)

7.1 General conditions

Documents should always be displayed in showcases. The permanent or long-term exhibition of any document is not recommended because of the expense and difficulty of providing safe and non-damaging conditions of display over a very long period. The security arrangements for the exhibition should be carefully planned.

7.2 Environmental conditions

Cases should not be placed in a position in which they are subject to wide or rapid fluctuations of temperature. Ideally, the temperature within the exhibition area should be controlled to within the range specified in section 5.1.2 above. There are two choices for controlling relative humidity: either the exhibition area should be air-conditioned to a suitable level (see section 5.1.1 above); in which case, showcases should be fitted with a filtered vent to allow them to respond to room humidity. Alternatively, cases should be sealed and relative humidity controlled by the use of preconditioned silica gel which is placed in plastic trays below the display deck. The use of 20kg of silica gel per cubic metre of case volume is suggested. In either situation, the environment within the showcases should be regularly monitored by the use of a dial hygrometer placed inside the case, or by an electronic meter inserted through a hole in the case (see sections 5.1.7.2. and 5.1.7.4.).

7.3 Display of bound volumes

This presents particular difficulties, because it is very hard to display open books for long periods without damaging their bindings. Volumes should not be displayed at an angle greater than 25 from the horizontal. They should be displayed on cradles which support their entire surface area; the bottom edge of the binding should be supported at all points by a ledge and the text block should have its own support. The volume should be held open by ribbons or straps of inert material which will not cut or damage the pages.

7.4 Protection against light

The level of illuminance on a document should not exceed 50 lux. The total exposure time should be limited: when the exhibition is closed, all lights should be extinguished and the showcases covered. Ultraviolet light should be excluded from the cases by using ultra violet filters in the glazing and around tubular fluorescent lamps. Spot lamps should not be directed at documents because they can cause shrinkage,warping and localised drying. Sunlight, which is a source of both heat and ultra violet light must not fall on the showcases. In spite of all these precautions, the display of certain materials, notably original colour photographs and fragile or badly processed black and white prints, cannot be safely recommended.

7.5 Protection against pollution

Atmospheric pollution is not a severe problem in a sealed showcase: sulphur dioxide, nitrogen oxides and ozone are absorbed in the fabric of the gallery. The real danger is the use of materials in the showcases which can emit hazardous chemicals. The worst risks come from hydrogen sulphide and weak organic acids (see sections 3.10.3 and 3.10.6 above). Acids and aldehydes are emitted from varnishes and paints based on oil drying technology (some oil based paints,alkyds and one pack polyurethanes, all generally soluble in white spirit). These can affect leather, parchment and photographs. The use of materials which can emit these chemicals is to be avoided. Cases should be constructed from materials that are non-destructive to the exhibits, or lined with materials which will provide protection; safe materials include metals, glass, ceramics, inorganic pigments, polyethylene, acrylic sheets, polycarbonates, polyester fabrics and undyed cotton or linen. Advice should be sought if other substances are being considered for use.

7.6 Security

Cases should be robustly constructed so that they cannot be moved either accidentally or maliciously and should remain level and free from distortion throughout the period of the exhibition. They should be glazed with strengthened glass and fitted with good quality locks.

7.7 Loans

Archivists, particularly in small repositories, sometimes face difficulties when being requested to lend material for display at another institution. Each archive should have a clearly defined policy for loans and should ensure that the documents will be exhibited in conditions which are as safe and

secure as those in the repository in which they are usually housed. It is important that the exhibition area is inspected and that transport and mounting arrangements are planned before the loan is agreed.

8. NON TRADITIONAL RECORDS

8.1 This section is concerned with the preservation of photographic materials (including films), computer records, sound recordings . Klaus B. Hendriks has prepared a separate RAMP study: The Preservation and restoration of Photographic Materials in archives and Libraries (Paris, Unesco, 1984 - PG1-84/WS/1) and these suggestions should be read in conjunction with that report. The preservation of non-traditional records is, inevitably, much more expensive than the preservation of documents on paper and parchment. Modern media are inherently much less stable than the older materials and they require much more precisely controlled environmental conditions: an air conditioned storage space and specialist storage equipment is normally required. Archives may need to cooperate to provide suitable facilities for the storage of such records.

8.2 Inherent instability: cellulose nitrate film

Some audio visual materials are inherently unstable. Cellulose nitrate, used for most films (except X-ray plates and 16mm home movies) produced before 1951 and for some sound recording discs is inherently unstable and may break down and spontaneously ignite. All pre-1951 film is suspect and should be tested; cellulose nitrate sinks in 1,1,1 trichloroethane, while safety film floats and is often labelled 'Safety'. Any nitrate material should be removed from the repository at once.

8.3 Inherent instability: photographic materials

Other types of photographs also exhibit a tendency to self destruct. Early albumen-based prints tend to discolour because of inherent faults in the process. (55) The worst problem facing archivists, however, is the tendency of colour photographic material to fade. Fading is a chemical process which occurs in the dark as much as in the light.It tends to affect the yellow dyes in the image rather than the magenta or cyan. Worst affected are colour prints and transparencies made on substantive films (e.g. Ektachrome). Rather better are silver dye bleach films and prints (e.g. Cibachrome) and transparencies made on non-substantive film (e.g. Kodachrome). Manufacturers have made real efforts to improve the longevity of their products, but even the best modern material is expected to show visible fading within 21 years. The problem is that in the next few years, archives are going to be accepting large quantities of colour

photographs; the output of colour paper exceeded that of black and white in 1972 and by 1981 it was three times as great. (56) Inevitably, this is going to affect the amount of colour materials which find their way into archives. This problem affects cinefilm as much as still photographs. It is generally accepted that even carefully preserved colour cinefilm will only have a life of about 25 years. (57)

8.4 Effect of relative humidity on photographs

The rate of fading of colour film is very much influenced by high temperature and high relative humidity. The rate of fading of colour film is up to 340 times as rapid at 24°C as at -18° C. (58) The fading of dyes principally occurs above 30%RH and the rate of fading is twice as fast at 60% as at 40%. Higher levels of relative humidity increase the level of activity of residual chemicals. Above about 60% RH, there is a risk that mould will grow; this is a particular problem with transparencies as anyone who has tried to store photographs in the tropics will know. Very dry conditions will embrittle the gelatine. Cycling of relative humidity can damage modern prints on resin-coated paper. The gelatine layer containing the image responds more rapidly to changes in relative humidity than the plastic coated base and can crack. (59)

8.5 Effects of environmental conditions on tapes and discs

High relative humidity can cause mould to grow on early discs and on the compounds used to splice tapes. (60) Cycling of temperature and relative humidity can have harmful effects on sound recording and computer tapes by causing changes in dimensions which may, in turn, cause damage to the signal and the oxide coating. (61)

8.6 Effects of air pollution

All these modern materials are also very susceptible to damage from air pollution. Sound recording discs and computer and sound tapes are easily damaged by particulates. Dust can contribute to loss of signal if it becomes trapped between layers of tape and can damage the backing and the magnetic coating. (62) Small particles in the grooves of discs can create distortion in playback and can lead to scratching. Photographic records can easily be harmed by air pollution. Particulates can make them dirty and cause scratching. Gaseous pollutants cause staining and fading of the image and may lead to the creation of 'redox blemishes'- yellow or red spots - on microfilms.

8.7 Environmental conditions for photographic materials

Black and white film should be stored at an RH of 30% and a temperature below 20°C. Prints should be stored at a constant

temperature and RH within the range 15-25°C and 30-50%RH. Colour material should be stored at a temperature of 2°C or below and an RH of 30%. As a compromise, all photographic materials (except for colour films and prints) can be stored at a constant temperature below 20°C and at a constant RH within the range 30-50%. (63) The provision of suitable conditions for colour material requires special facilities and equipment. A room should be provided with a dehumidifier fitted with a humidistat. The films can be conditioned to the correct relative humidity and then sealed into containers and placed in freezers (domestic or commercial models can be used). An area will also be needed where the films can warm up in their containers before opening and use. (64)

8.8 Environmental conditions for computer and sound records

For sound recordings, the suggested ranges are 40-55%RH and 10-21°C for discs and 40-60% and 4-16°C for tapes. (65) The conditions should be constant within these ranges and the air should be purified of pollutants. For computer tapes, it is recommended that they be stored at a constant temperature and RH within the range 5-32°C and 20-80%; the air should be dust free and the storage area should be shielded from electro-magnetic interference. (66)

8.9 Storage for sound recording discs

Discs should be placed in soft polyethylene covers inside tough card outer covers. The original covers should be stored separately. The discs should be stored upright on shelves in ventilated metal cabinets divided into sections of 150-225 mm with sufficient lateral pressure to prevent warping. They should be grouped according to size and different sizes should not be stored together. (67)

8.10 Storage for computer and sound recording tapes

Each tape reel should be kept in an aluminium, or inert cardboard or plastic container, placed in a self-sealing polyethylene bag and stored upright on a metal rack. Cassettes can be kept in their original boxes and these placed inside polyethylene bags. Sound tapes should be rewound every year at playback speed to reverse the curvature of the type. Computer tape should be rewound and retensioned every six months and (if resources allow) recopied every twelve months. (68)

8.11 Storage for photographic prints

Prints should be placed in envelopes made either from inert, acid free paper (high alpha-cellulose, pH 6.5 - 7.5) or uncoated polyethylene, uncoated cellulose acetate or polyethylene terephthalate. These can be sewn up to form volumes or kept

separate and stored either in boxes made from inert cardboard materials or in metal filing cabinets or drawers. (69)

8.12 Storage for photographic films

The films should be wound on inert plastic or non-ferrous metal reels and stored in cans made from similar materials. Steel cans with a corrosion resistant finish are acceptable. Rubber bands should not be used to hold the films in place; acid free paper and undyed cotton are acceptable. Small strips of film can safely be stored in envelopes or sleeves made from polyethylene or polyethylene terephthalate. (70)

9. GUIDELINES

References in parentheses are to the relevant paragraphs in the study.

9.1 Introduction

This study is concerned with the protection of records against unsuitable environmental conditions, air pollution, light, theft, damage, fire, water, insects, mould and vermin. These hazards are described in detail (3.1-3.12).

9.2 Specific Recommendations

9.2.1 Location of building

The building should be on a site which is free from natural and man made hazards, is large enough to accommodate future extensions, is close to users and provides suitable environmental conditions. (4.1).

9.2.2 Building structure

The building should provide protection against natural hazards and have a high degree of thermal inertia to ensure that the interior temperature and relative humidity remain reasonably stable and unaffected by fluctuations in the exterior conditions. (4.2).

9.2.3 Maintenance of safe and stable climate

The main priority for climatic control is to ensure a suitable level of relative humidity which should be stable and within the range 45-65%. The actual level chosen should be close to local climatic conditions. The ideal temperature should be between 15 and 22°C. There are a number of alternative methods of controlling the climate. (5.1).

9.2.4 Protection against air pollution

It is possible to provide protection against indoor sources of pollution by good planning and sensible work practices. Outdoor sources of pollution can only be totally controlled by full air conditioning, although there are a few simple steps which can reduce the impact of polluted air. Cleaning is vitally important in the fight against pollution. (5.2).

9.2.5 Protection against light

Provided that all records are boxed, there is little danger from light in the repository, although it should be kept off the face of shelving. The principles to be observed in designing lighting for archive buildings are safety, practicality and economy. (5.3).

9.2.6 Security

The problem of security in archives may be greater than is generally realized. New staff should undergo background checks and the identity of readers should be confirmed. One official should be given responsibility for security, although all staff should be encouraged to have a positive attitude towards it. Security procedures should be carefully defined and strictly enforced, particularly in the repository and reading rooms. Special care should be taken to protect fragile or valuable items. There should be a comprehensive set of rules governing the conduct of readers (a simple model for such rules is given). The design of the building is important in preserving security and special attention should be given to the problems of shared buildings and the possible use of electronic security measures. (5.4).

9.2.7 Protection against physical damage

The most important ways to protect documents are to pack them properly and to train and motivate the staff. There is a major risk of damage when records are being photocopied or filmed and safe working procedures must be established. (5.5).

9.2.8 Protection against fire

Prevention of fire requires special work practices, building design and the installation of systems for detection and extinction. (5.6).

9.2.9 Protection against water

The major dangers are from storms, failures of plumbing and firefighting. They can be minimized by good maintenance, by

avoiding the use of basements and by other techniques, including the use of sensors which detect flooding. All archives should have a disaster plan for dealing with severe flooding. (5.7).

9.2.10 Protection against insects, mould and pests

Technical methods are required for dealing with these pests. Care is always needed in the choice and use of substances potentially harmful to people. (5.8).

9.2.11 Shelving and packing

Minimum requirements should be prescribed for shelving and for the materials and methods used to pack volumes, files and loose sheets, outsize documents and seals. (6.1-6.2).

9.2.12 Exhibitions

The exhibition of documents presents a conflict between the need to preserve material and the desire to make it available. The main problems are the requirement to maintain a stable environment, the difficulty of displaying bound volumes safely, the provision of protection against light and pollution and the necessity of providing a high level of security. It is also important to have a clear policy on lending material for exhibitions. (7.1-7.7).

9.2.13 Non traditional materials

Photographs, sound recordings and computer tapes are much more susceptible to damage due to unsuitable environmental conditions and atmospheric pollution than are traditional records. While it may be possible to preserve conventional records without using elaborate methods of controlling the environment, these materials will not survive without sophisticated air conditioning. (8.1-8.12).

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This study is based, in part, on a paper read by the author at an international seminar on archive buildings held in Vienna in October/November 1985. The seminar was organised by the International Council on Archives and the Austrian State Archives and the paper is to be published in the journal of the Austrian State Archives. It is also partly based on an early draft submitted to the ICA by Mr Kishore of the Indian National Archives. I am grateful to Michael Roper, Michael Pascoe and Frank B.Evans for their comments.

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